



MOTOROLA

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MC33078 MC33079

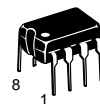
Dual/Quad Low Noise Operational Amplifiers

The MC33078/9 series is a family of high quality monolithic amplifiers employing Bipolar technology with innovative high performance concepts for quality audio and data signal processing applications. This family incorporates the use of high frequency PNP input transistors to produce amplifiers exhibiting low input voltage noise with high gain bandwidth product and slew rate. The all NPN output stage exhibits no deadband crossover distortion, large output voltage swing, excellent phase and gain margins, low open loop high frequency output impedance and symmetrical source and sink AC frequency performance.

The MC33078/9 family offers both dual and quad amplifier versions, tested over the automotive temperature range and available in the plastic DIP and SOIC packages (P and D suffixes).

- Dual Supply Operation: ± 5.0 V to ± 18 V
- Low Voltage Noise: $4.5 \text{ nV}/\sqrt{\text{Hz}}$
- Low Input Offset Voltage: 0.15 mV
- Low T.C. of Input Offset Voltage: $2.0 \mu\text{V}/^\circ\text{C}$
- Low Total Harmonic Distortion: 0.002%
- High Gain Bandwidth Product: 16 MHz
- High Slew Rate: $7.0 \text{ V}/\mu\text{s}$
- High Open Loop AC Gain: 800 @ 20 kHz
- Excellent Frequency Stability
- Large Output Voltage Swing: $+14.1 \text{ V}/-14.6 \text{ V}$
- ESD Diodes Provided on the Inputs

DUAL/QUAD LOW NOISE OPERATIONAL AMPLIFIERS

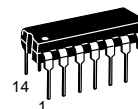
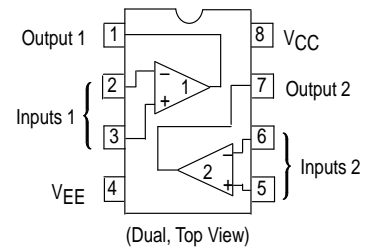


P SUFFIX
PLASTIC PACKAGE
CASE 626

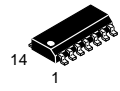


D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO-8)

PIN CONNECTIONS

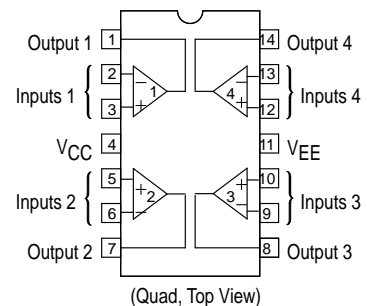


P SUFFIX
PLASTIC PACKAGE
CASE 646

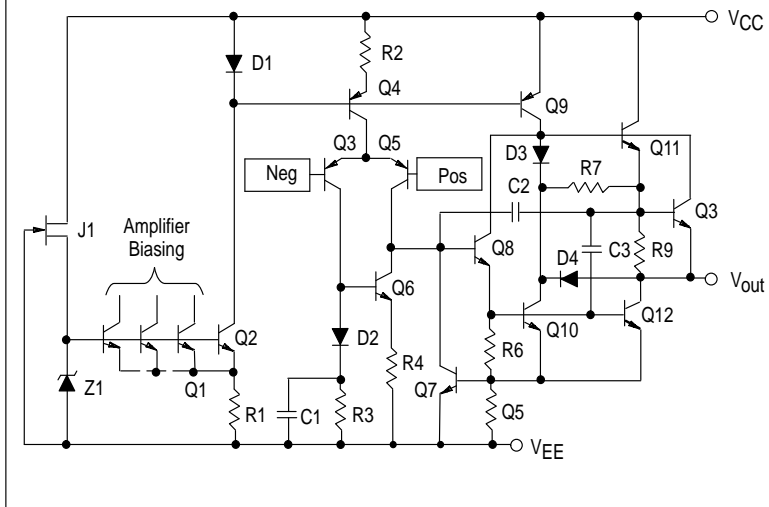


D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO-14)

PIN CONNECTIONS



Representative Schematic Diagram (Each Amplifier)



ORDERING INFORMATION

| Device | Operating Temperature Range | Package |
|----------------------|---|----------------------|
| MC33078D MC33078P | $T_A = -40^\circ \text{ to } +85^\circ\text{C}$ | SO-8 Plastic DIP |
| MC33079D MC33079P | | SO-14 Plastic DIP |

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MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------|-------------|------|
| Supply Voltage (V_{CC} to V_{EE}) | V_S | +36 | V |
| Input Differential Voltage Range | V_{IDR} | (Note 1) | V |
| Input Voltage Range | V_{IR} | (Note 1) | V |
| Output Short Circuit Duration (Note 2) | t_{SC} | Indefinite | sec |
| Maximum Junction Temperature | T_J | +150 | °C |
| Storage Temperature | T_{stg} | -60 to +150 | °C |
| Maximum Power Dissipation | P_D | (Note 2) | mW |

- NOTES:** 1. Either or both input voltages must not exceed the magnitude of V_{CC} or V_{EE} .
 2. Power dissipation must be considered to ensure maximum junction temperature (T_J) is not exceeded (see Figure 1).

DC ELECTRICAL CHARACTERISTICS ($V_{CC} = +15$ V, $V_{EE} = -15$ V, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|--|------------------------------------|--|----------------------------------|------------------------------|
| Input Offset Voltage ($R_S = 10 \Omega$, $V_{CM} = 0$ V, $V_O = 0$ V) (MC33078) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ (MC33079) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | $ V_{IO} $ | — — — — | 0.15 — 0.15 — | 2.0 3.0 2.5 3.5 | mV |
| Average Temperature Coefficient of Input Offset Voltage $R_S = 10 \Omega$, $V_{CM} = 0$ V, $V_O = 0$ V, $T_A = T_{low}$ to T_{high} | $\Delta V_{IO}/\Delta T$ | — | 2.0 | — | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current ($V_{CM} = 0$ V, $V_O = 0$ V) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | I_{IB} | — — | 300 — | 750 800 | nA |
| Input Offset Current ($V_{CM} = 0$ V, $V_O = 0$ V) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | I_{IO} | — — | 25 — | 150 175 | nA |
| Common Mode Input Voltage Range ($\Delta V_{IO} = 5.0$ mV, $V_O = 0$ V) | V_{ICR} | ± 13 | ± 14 | — | V |
| Large Signal Voltage Gain ($V_O = \pm 10$ V, $R_L = 2.0$ k Ω) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | A_{VOL} | 90 85 | 110 — | — — | dB |
| Output Voltage Swing ($V_{ID} = \pm 1.0$ V) $R_L = 600 \Omega$ $R_L = 600 \Omega$ $R_L = 2.0$ k Ω $R_L = 2.0$ k Ω $R_L = 10$ k Ω $R_L = 10$ k Ω | V_{O+} V_{O-} V_{O+} V_{O-} V_{O+} V_{O-} | — — +13.2 — +13.5 — | +10.7 -11.9 +13.8 -13.7 +14.1 -14.6 | — — — -13.2 — -14 | V |
| Common Mode Rejection ($V_{in} = \pm 13$ V) | CMR | 80 | 100 | — | dB |
| Power Supply Rejection (Note 3) $V_{CC}/V_{EE} = +15$ V/-15 V to +5.0 V/-5.0 V | PSR | 80 | 105 | — | dB |
| Output Short Circuit Current ($V_{ID} = 1.0$ V, Output to Ground) Source Sink | I_{SC} | +15 -20 | +29 -37 | — — | mA |
| Power Supply Current ($V_O = 0$ V, All Amplifiers) (MC33078) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ (MC33079) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | I_D | — — — — | 4.1 — 8.4 — | 5.0 5.5 10 11 | mA |

- NOTE:** 3. Measured with V_{CC} and V_{EE} differentially varied simultaneously.

MC33078 MC33079

AC ELECTRICAL CHARACTERISTICS ($V_{CC} = +15\text{ V}$, $V_{EE} = -15\text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

| Characteristics | Symbol | Min | Typ | Max | Unit | |
|---|--|----------|-------|------|------------------------------|---------|
| Slew Rate ($V_{in} = -10\text{ V}$ to $+10\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $C_L = 100\text{ pF}$, $A_V = +1.0$) | SR | 5.0 | 7.0 | — | V/ μs | |
| Gain Bandwidth Product ($f = 100\text{ kHz}$) | GBW | 10 | 16 | — | MHz | |
| Unity Gain Frequency (Open Loop) | f_U | — | 9.0 | — | MHz | |
| Gain Margin ($R_L = 2.0\text{ k}\Omega$) | $C_L = 0\text{ pF}$ $C_L = 100\text{ pF}$ | A_m | — | -11 | — | dB |
| | | | — | -6.0 | — | |
| Phase Margin ($R_L = 2.0\text{ k}\Omega$) | $C_L = 0\text{ pF}$ $C_L = 100\text{ pF}$ | ϕ_m | — | 55 | — | Degrees |
| | | | — | 40 | — | |
| Channel Separation ($f = 20\text{ Hz}$ to 20 kHz) | CS | — | -120 | — | dB | |
| Power Bandwidth ($V_O = 27\text{ V}_{pp}$, $R_L = 2.0\text{ k}\Omega$, $\text{THD} \leq 1.0\%$) | BW_p | — | 120 | — | kHz | |
| Distortion ($R_L = 2.0\text{ k}\Omega$, $f = 20\text{ Hz}$ to 20 kHz , $V_O = 3.0\text{ V}_{rms}$, $A_V = +1.0$) | THD | — | 0.002 | — | % | |
| Open Loop Output Impedance ($V_O = 0\text{ V}$, $f = 9.0\text{ MHz}$) | $ Z_O $ | — | 37 | — | Ω | |
| Differential Input Resistance ($V_{CM} = 0\text{ V}$) | R_{IN} | — | 175 | — | $\text{k}\Omega$ | |
| Differential Input Capacitance ($V_{CM} = 0\text{ V}$) | C_{IN} | — | 12 | — | pF | |
| Equivalent Input Noise Voltage ($R_S = 100\ \Omega$, $f = 1.0\text{ kHz}$) | e_n | — | 4.5 | — | $\text{nV}/\sqrt{\text{Hz}}$ | |
| Equivalent Input Noise Current ($f = 1.0\text{ kHz}$) | i_n | — | 0.5 | — | $\text{pA}/\sqrt{\text{Hz}}$ | |

Figure 1. Maximum Power Dissipation versus Temperature

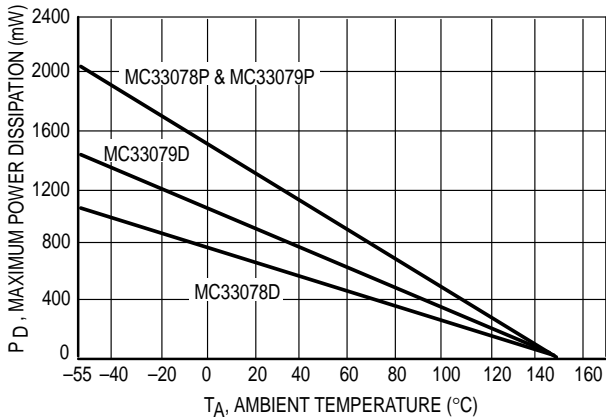


Figure 2. Input Bias Current versus Supply Voltage

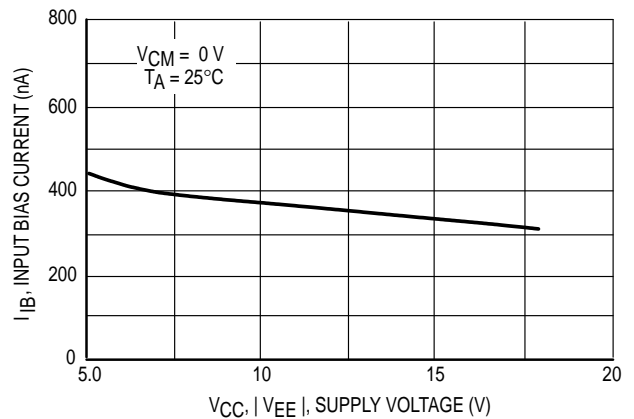


Figure 3. Input Bias Current versus Temperature

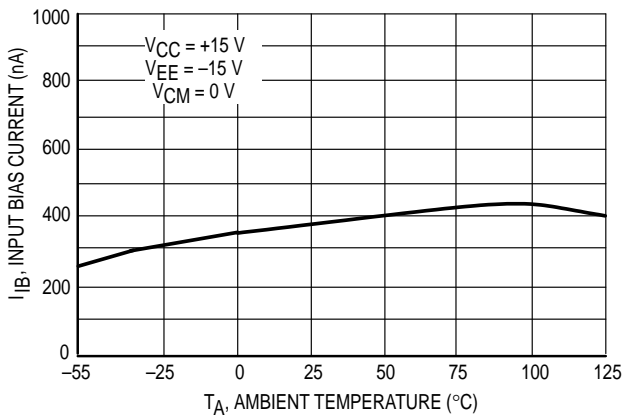
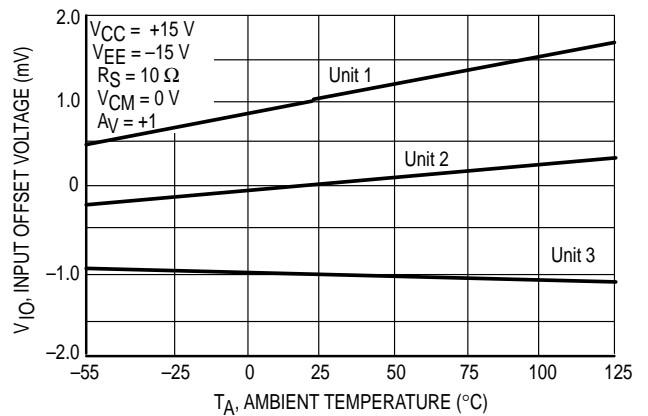


Figure 4. Input Offset Voltage versus Temperature



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Figure 5. Input Bias Current versus Common Mode Voltage

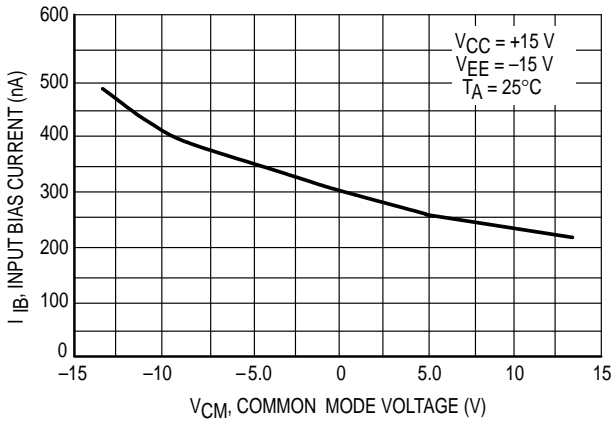


Figure 6. Input Common Mode Voltage Range versus Temperature

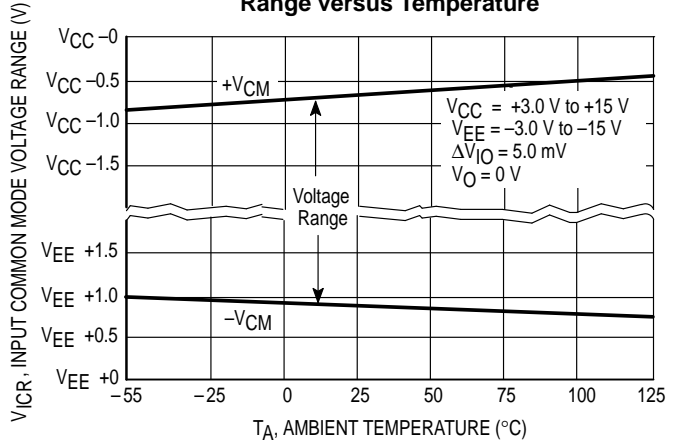


Figure 7. Output Saturation Voltage versus Load Resistance to Ground

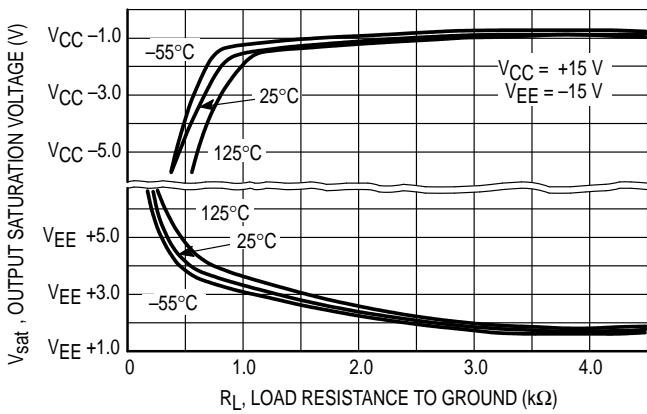


Figure 8. Output Short Circuit Current versus Temperature

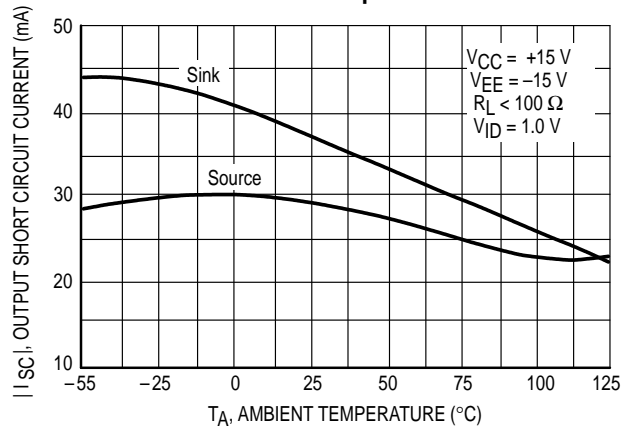


Figure 9. Supply Current versus Temperature

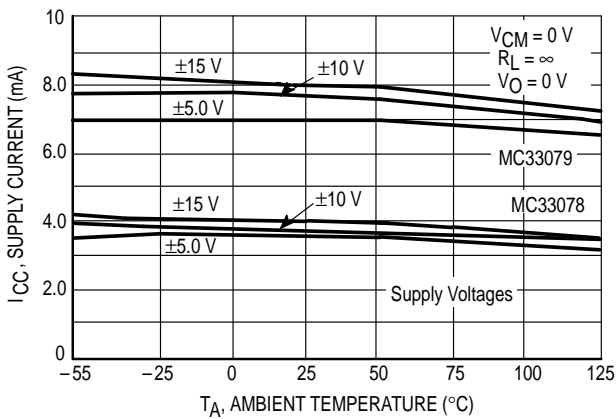
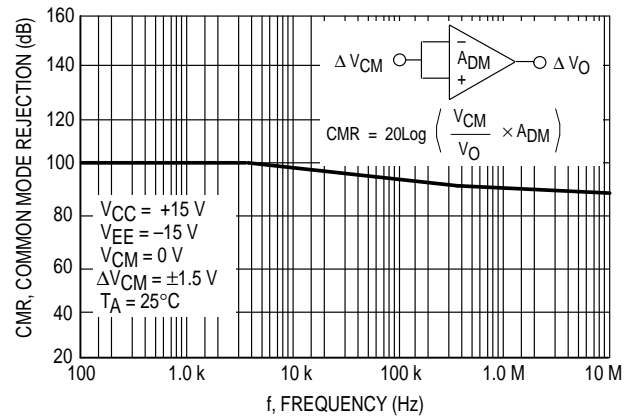


Figure 10. Common Mode Rejection versus Frequency



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Figure 11. Power Supply Rejection versus Frequency

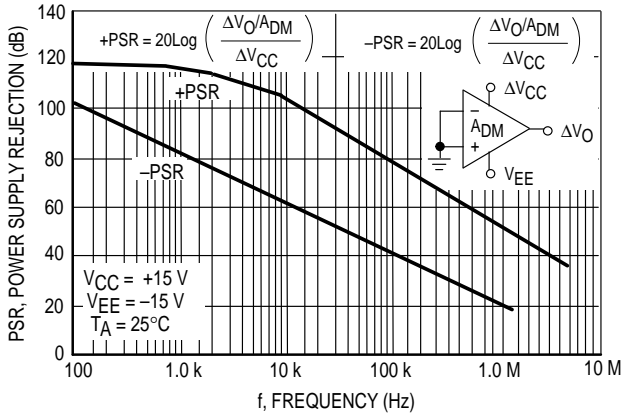


Figure 12. Gain Bandwidth Product versus Supply Voltage

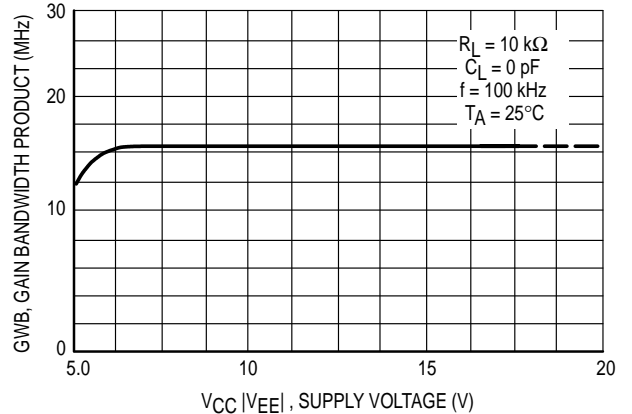


Figure 13. Gain Bandwidth Product versus Temperature

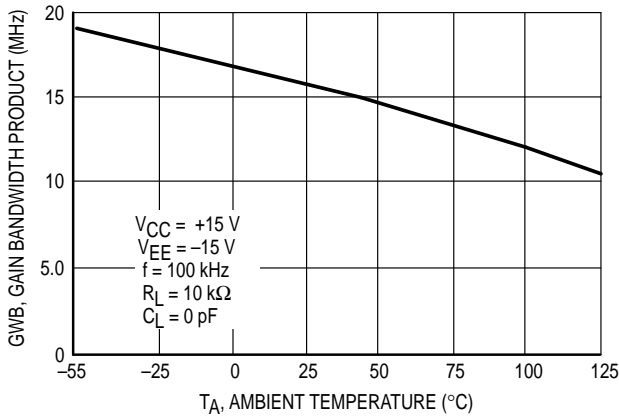


Figure 14. Maximum Output Voltage versus Supply Voltage

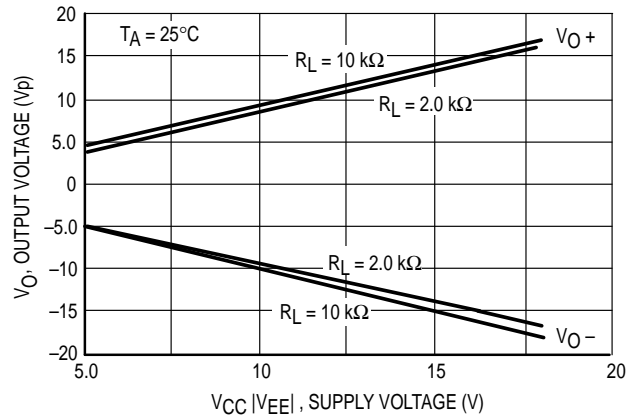


Figure 15. Output Voltage versus Frequency

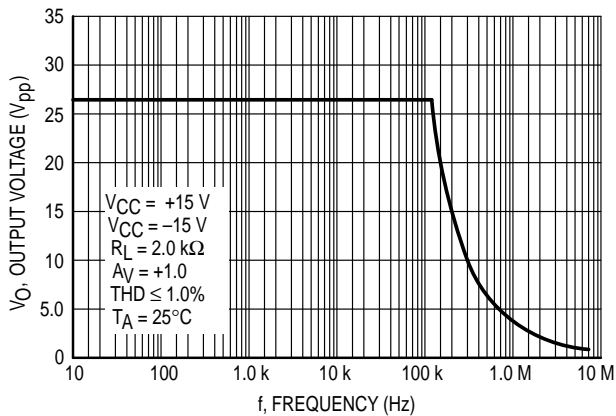
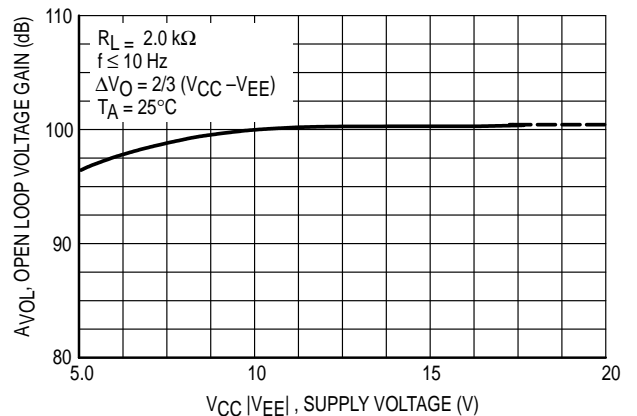


Figure 16. Open Loop Voltage Gain versus Supply Voltage



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Figure 17. Open Loop Voltage Gain versus Temperature

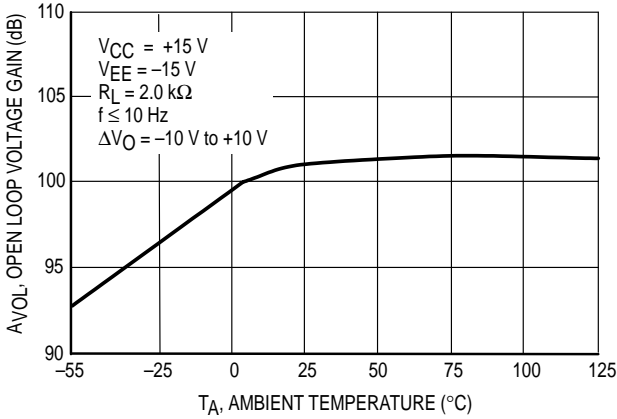


Figure 18. Output Impedance versus Frequency

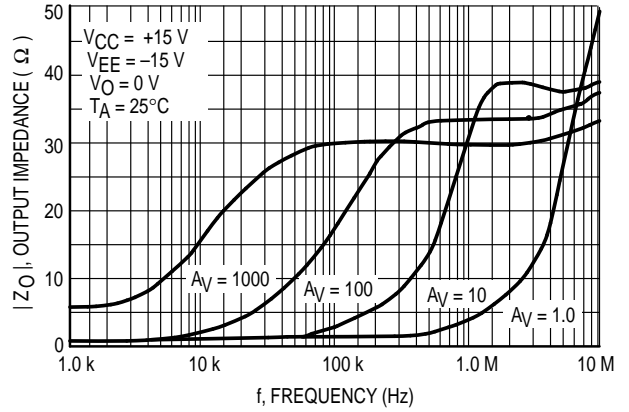


Figure 19. Channel Separation versus Frequency

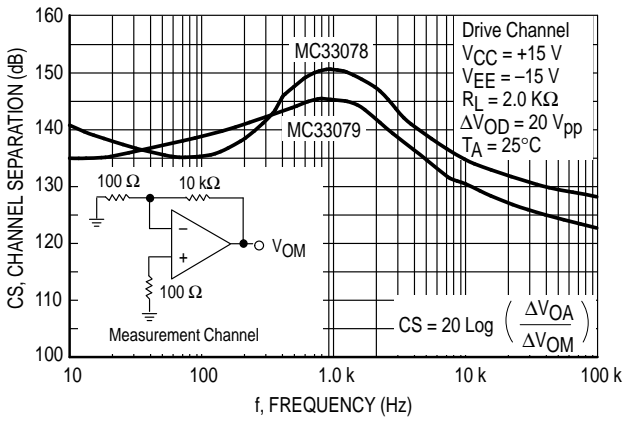


Figure 20. Total Harmonic Distortion versus Frequency

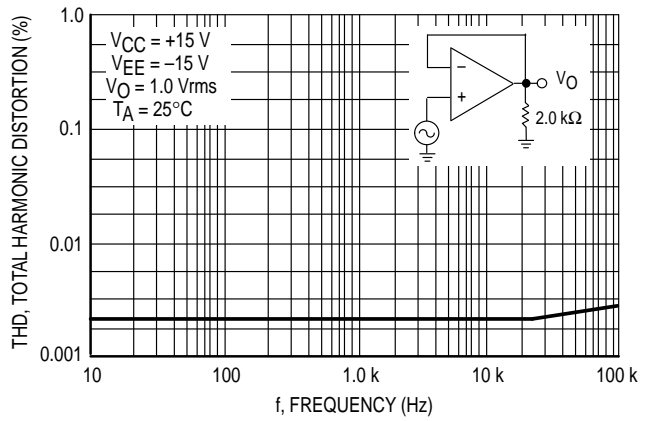


Figure 21. Total Harmonic Distortion versus Output Voltage

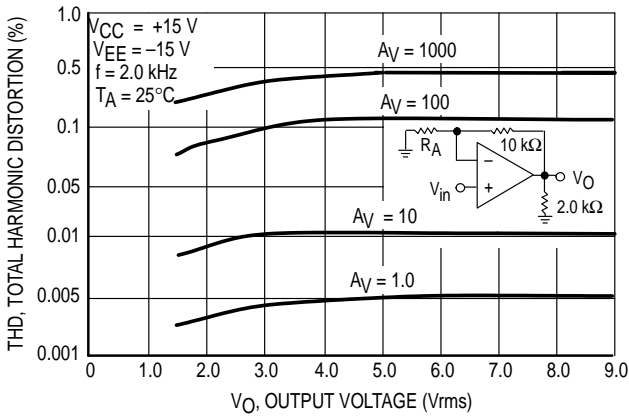
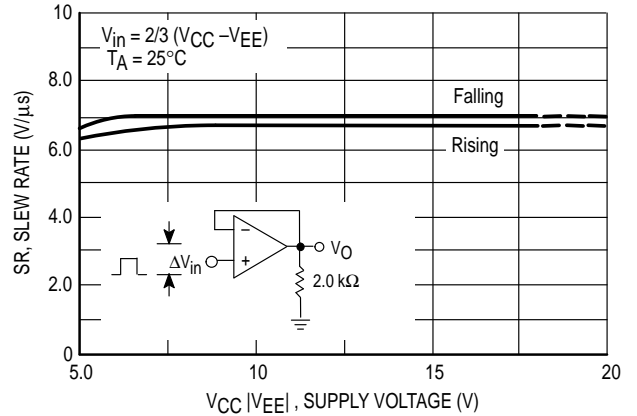


Figure 22. Slew Rate versus Supply Voltage



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Figure 23. Slew Rate versus Temperature

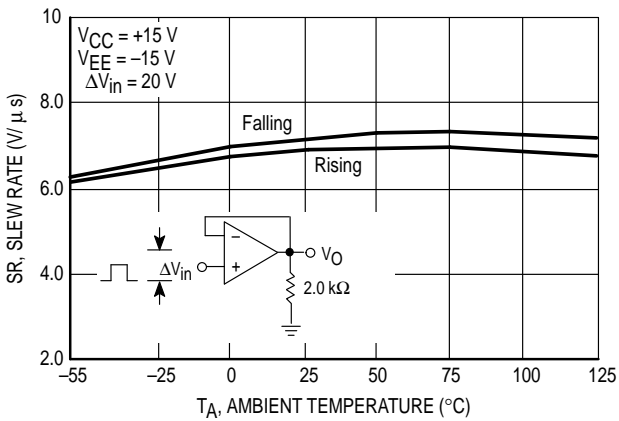


Figure 24. Voltage Gain and Phase versus Frequency

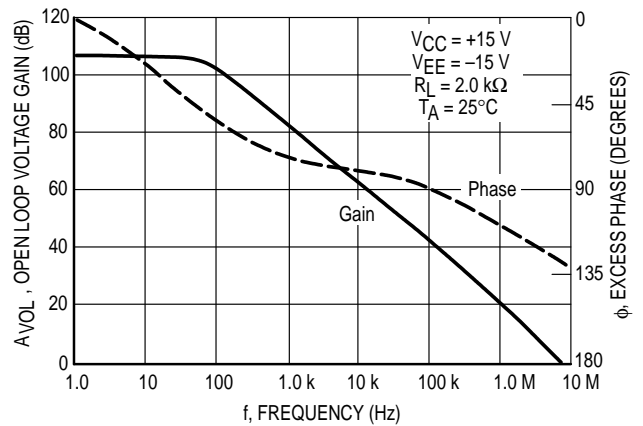


Figure 25. Open Loop Gain Margin and Phase Margin versus Load Capacitance

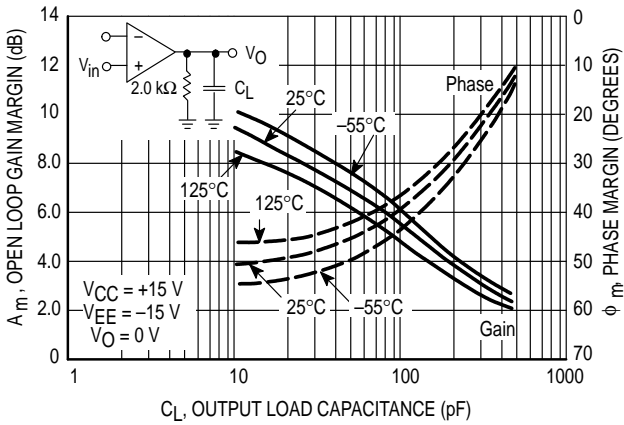


Figure 26. Overshoot versus Output Load Capacitance

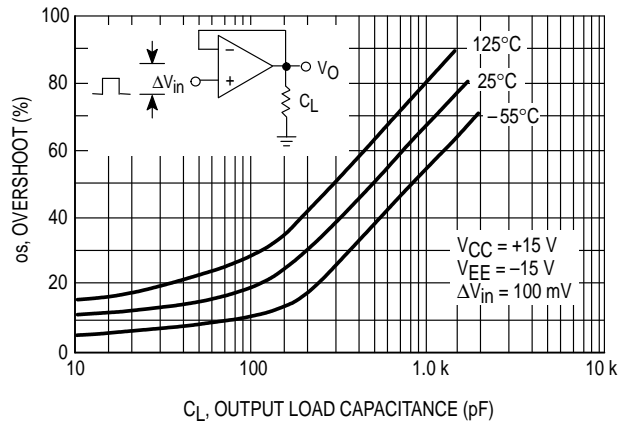


Figure 27. Input Referred Noise Voltage and Current versus Frequency

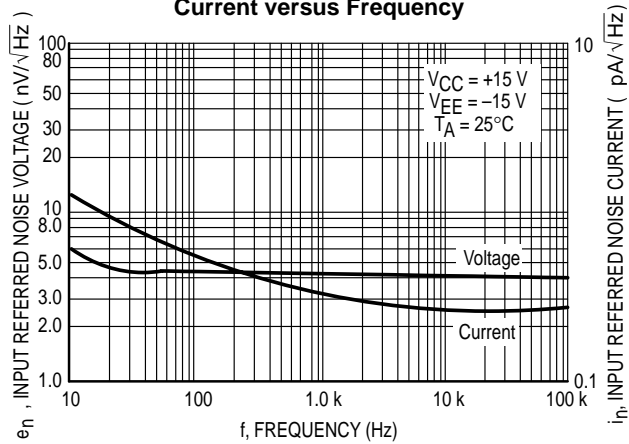
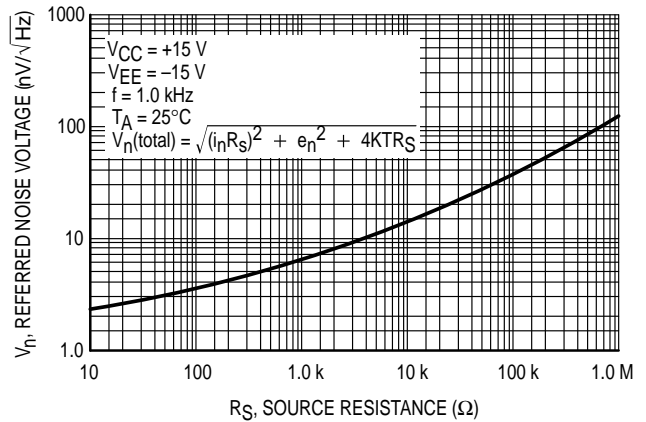


Figure 28. Total Input Referred Noise Voltage versus Source Resistance



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Figure 29. Phase Margin and Gain Margin versus Differential Source Resistance

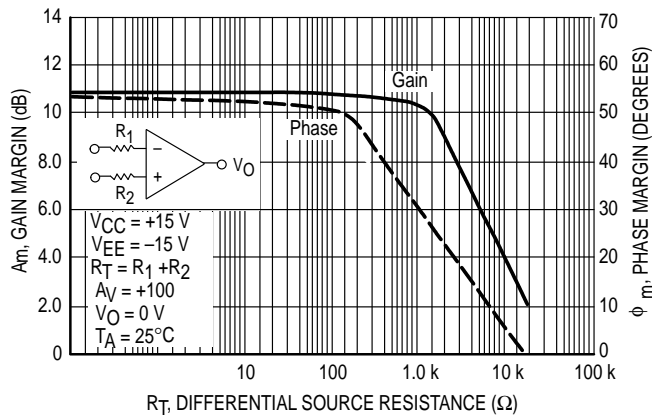


Figure 30. Inverting Amplifier Slew Rate

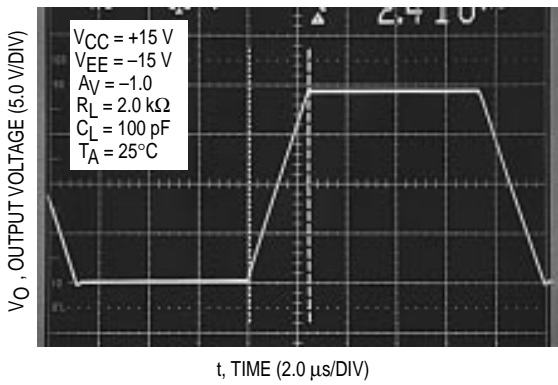


Figure 31. Noninverting Amplifier Slew Rate

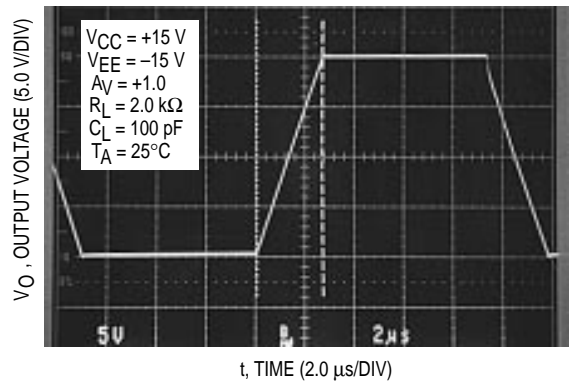


Figure 32. Noninverting Amplifier Overshoot

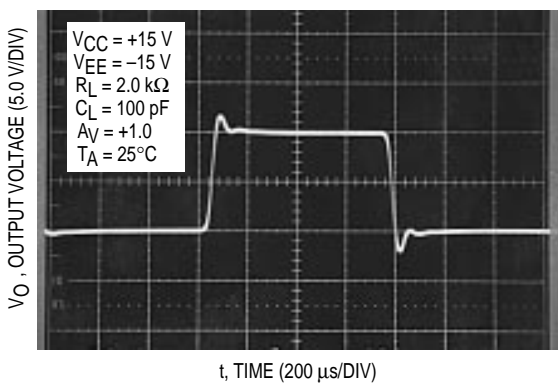
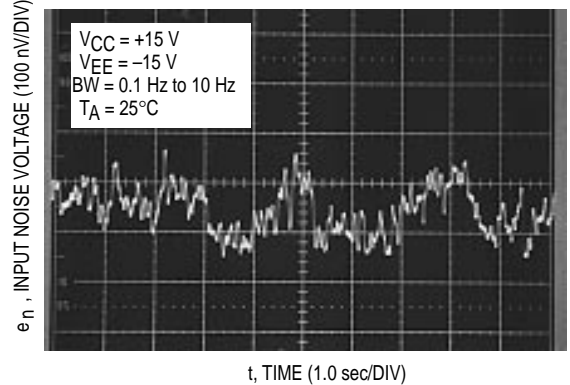
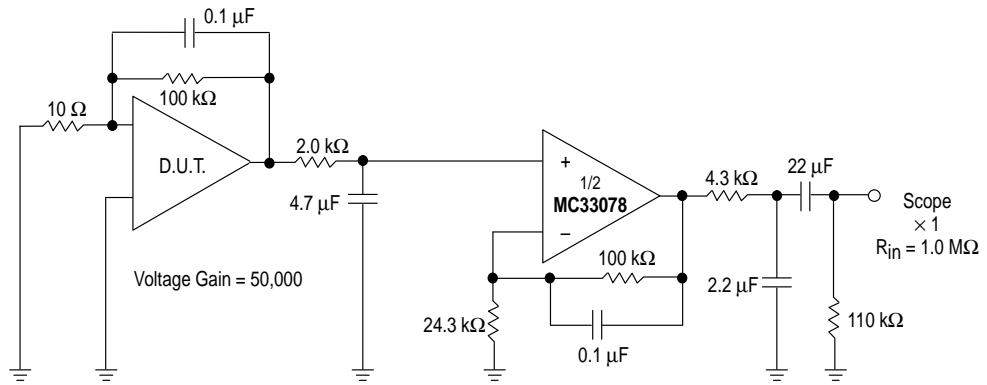


Figure 33. Low Frequency Noise Voltage versus Time



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Figure 34. Voltage Noise Test Circuit
(0.1 Hz to 10 Hz_{p-p})

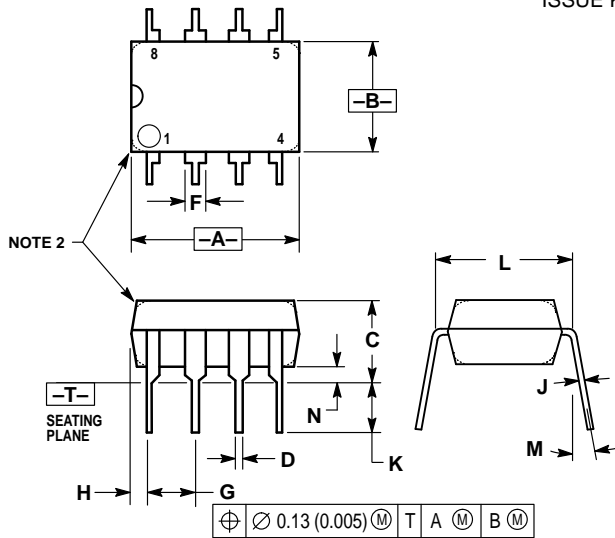


Note: All capacitors are non-polarized.

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OUTLINE DIMENSIONS

P SUFFIX PLASTIC PACKAGE CASE 626-05 ISSUE K

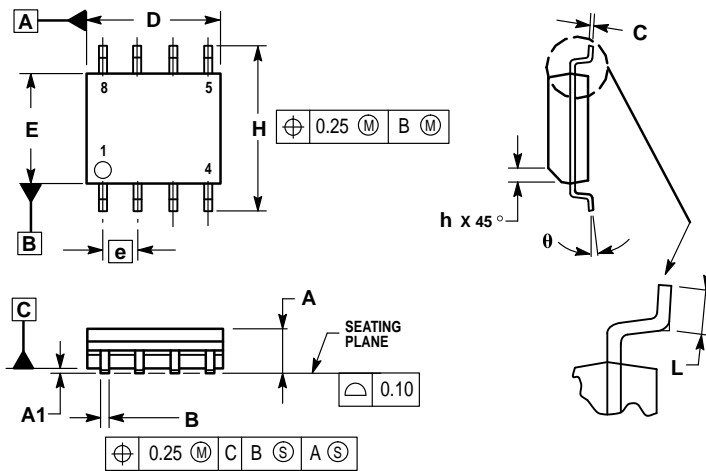


NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 9.40 | 10.16 | 0.370 | 0.400 |
| B | 6.10 | 6.60 | 0.240 | 0.260 |
| C | 3.94 | 4.45 | 0.155 | 0.175 |
| D | 0.38 | 0.51 | 0.015 | 0.020 |
| F | 1.02 | 1.78 | 0.040 | 0.070 |
| G | 2.54 BSC | | 0.100 BSC | |
| H | 0.76 | 1.27 | 0.030 | 0.050 |
| J | 0.20 | 0.30 | 0.008 | 0.012 |
| K | 2.92 | 3.43 | 0.115 | 0.135 |
| L | 7.62 BSC | | 0.300 BSC | |
| M | — | | 10° | |
| N | 0.76 | 1.01 | 0.030 | 0.040 |

D SUFFIX PLASTIC PACKAGE CASE 751-05 (SO-8) ISSUE R



NOTES:

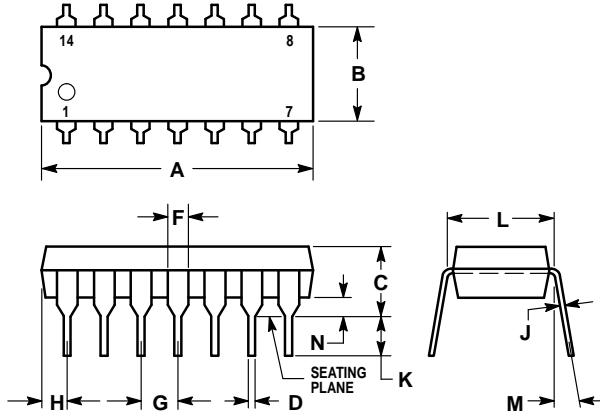
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | |
|-----|-------------|------|
| | MIN | MAX |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| B | 0.35 | 0.49 |
| C | 0.18 | 0.25 |
| D | 4.80 | 5.00 |
| E | 3.80 | 4.00 |
| e | 1.27 BSC | |
| H | 5.80 | 6.20 |
| h | 0.25 | 0.50 |
| L | 0.40 | 1.25 |
| θ | 0° 7° | |

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OUTLINE DIMENSIONS

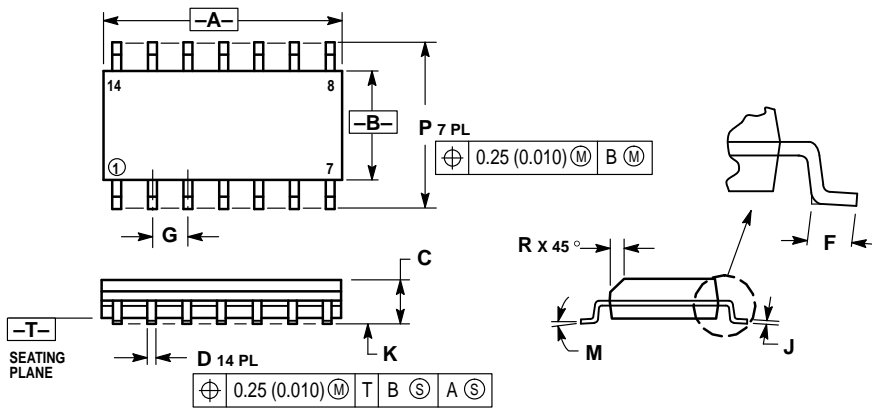
P SUFFIX PLASTIC PACKAGE CASE 646-06 ISSUE L



- NOTES:
- LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
 - DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
 - DIMENSION B DOES NOT INCLUDE MOLD FLASH.
 - ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.715 | 0.770 | 18.16 | 19.56 |
| B | 0.240 | 0.260 | 6.10 | 6.60 |
| C | 0.145 | 0.185 | 3.69 | 4.69 |
| D | 0.015 | 0.021 | 0.38 | 0.53 |
| F | 0.040 | 0.070 | 1.02 | 1.78 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.052 | 0.095 | 1.32 | 2.41 |
| J | 0.008 | 0.015 | 0.20 | 0.38 |
| K | 0.115 | 0.135 | 2.92 | 3.43 |
| L | 0.300 BSC | | 7.62 BSC | |
| M | 0° | 10° | 0° | 10° |
| N | 0.015 | 0.039 | 0.39 | 1.01 |


D SUFFIX PLASTIC PACKAGE CASE 751A-03 (SO-14) ISSUE F



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 - CONTROLLING DIMENSION: MILLIMETER.
 - DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
 - MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
 - DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 8.55 | 8.75 | 0.337 | 0.344 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.054 | 0.068 |
| D | 0.35 | 0.49 | 0.014 | 0.019 |
| F | 0.40 | 1.25 | 0.016 | 0.049 |
| G | 1.27 BSC | | 0.050 BSC | |
| J | 0.19 | 0.25 | 0.008 | 0.009 |
| K | 0.10 | 0.25 | 0.004 | 0.009 |
| M | 0° | 7° | 0° | 7° |
| P | 5.80 | 6.20 | 0.228 | 0.244 |
| R | 0.25 | 0.50 | 0.010 | 0.019 |

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